CO_2 Capture Project

Moving the Knowledge and Experience Base Forward

Gardiner Hill, BP
Chairman of CCP Board

www.co2capturereproject.org

US DOE –NETL 3rd Annual Carbon Sequestration Conference
May 4 6 2004

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This study and presentation was prepared with the support of the U.S. Department of Energy under Award No. DE-FC-26-01NT41145 and any opinions, findings, conclusions or recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the DOE.

CO_2 Capture Project

Introduction

- Background on CO_2 Capture Project
  - Cooperating for a better environment
  - Program structure
  - Project objectives
- Project Progress and Timeline
- Overview of CCP Findings
  - Capture
  - Geologic storage
  - Progress of other program areas
    - Policy, Technology Advisory Board and Communications
- Conclusions

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Cooperating For A Better Environment

NETL US Dept. of Energy
National Energy Technology Laboratory
David Hyman, Program Manager

EU DG Research
Directorate-General Research
Program Manager: Dennis O'Brien

Norges forskningsråd
The Research Council of Norway
Program Manager: Hans-Roar Sæarheim

EU DG Energy and Transport
Directorate-General Energy and Transport
Program Manager: Vassilios Kougionas

Joint Industry Partnership (JIP)

bp · Chevrontexaco · EnCana · Eni · Hydro · Shell · Statoil · Suncor

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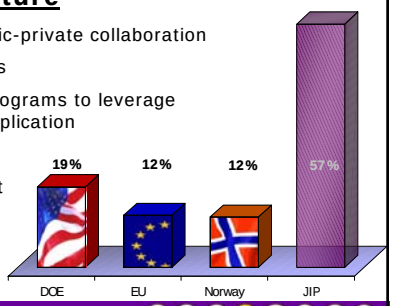
Project Structure

- International public-private collaboration
- Regional programs
- Sharing among programs to leverage results, reduce duplication
- $25m Funding
- $50m Project Cost



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CO_2 Capture Project - Objectives

- Achieve major reductions in cost of CO_2 capture & storage:
  - 50% reduction when applied to a retrofit application.
  - 75% reduction when applied to a new build application.
- Demonstrate to external stakeholders that CO_2 storage is safe, measurable, and verifiable.
- Progress technologies to:
  - 'Proof of concept' stage by 2003/4 (Commercialization post 2010).

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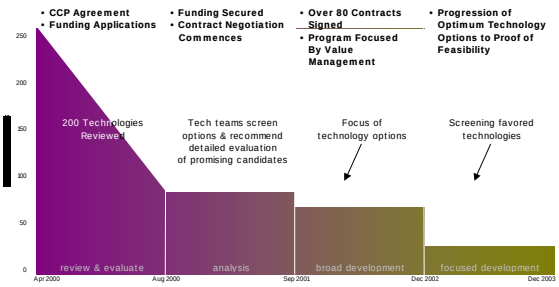
Project Overview *we've come a long way!*



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Overview of CCP Findings

Capture

- Made significant headway in developing technology, resulting in step reduction in costs and importantly, ruled out some technologies

Storage

- Identified a comprehensive suite of questions we must address, to understand and demonstrate long term secure storage. Pioneered the risk based approach for site identification, operation and monitoring

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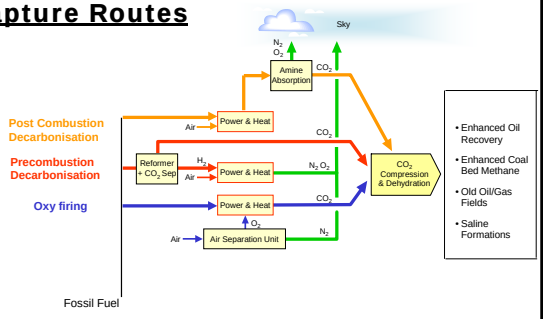
Capture Routes



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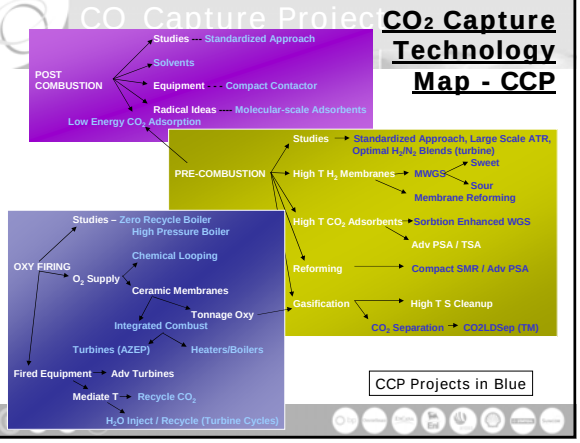
CO_2 Capture Technology Map - CCP



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Capture: Precombustion - Top Technologies

- **Sorption Enhanced Water Gas Shift** (Air Products)
  - Field demonstration by 2007+
  - CO_2 avoided cost reduction ~ 50%
- **Membrane Water Gas Shift**
  - Two alternative membrane compositions: Eltron and SINTEF.
  - Both could be ready for field demonstration by 2007+
  - CO_2 avoided cost reduction ~ 50%.
- **Hydrogen Membrane Reformer** (Hydro)
  - Field demonstration by 2008-10
  - Potential to reduce the cost of CO_2 avoided by over 60%

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Capture: Other – Top Technologies

- **Oxy-firing, Chemical Looping** (Chalmers, Alstom et al)
  - Could be ready for field demonstration 2007+
  - CO_2 avoided cost reduction ~ 38%
- **Post-Combustion, Design Integration** (Nexant)
  - Ready for field demonstration today
  - CO_2 avoided cost reduction ~ 55%
- **Common Economic Model**
  - Allows cross technology comparisons on a common basis.
  - Used to compare CCP technologies across four real-life scenarios.

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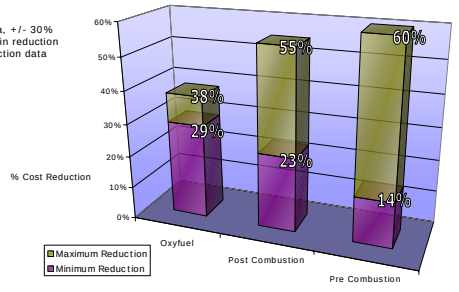
Capture: CO_2 Avoided Cost Reductions*

* Preliminary data, +/- 30% cost estimates, min reduction & maximum reduction data points shown.



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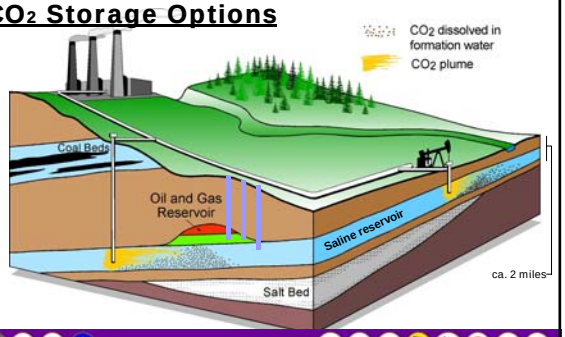
CO_2 Storage Options



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Storage: Technologies Delivered

- Developed a **comprehensive understanding of the HSE risks** of, and the requirements for, secure geological storage
  - Geological formations more likely to be secure than man-made wells
  - Depleted oil & gas fields generally be more secure than saline formations
- Assembled a **large database of knowledge**, which will allow the risks associated with geological storage to be quantified and compared to other activities
- Developed an extensive repertoire of **monitoring options**, applicable to a broad range of settings
- Potential **leakage scenarios** have been mapped and matched to remediation actions

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Risk Assessment

Comprehensive Methodologies
- Tools, Scenarios, Models (TNO, INEL)
- Testing On & Offshore Aquifers (TNO)
- Leakage Risk & Failure Scenarios (INEL)

Mitigation & Remediation
- Leak Scenarios & Response (LBNL)

Environmental / Regulatory / Public Perception
- HSE Review (LBNL)
- Effect on Subsurface Ecosystems (Princeton)
- Lessons on Honesty & Transparency (MSCI)

Optimization

Hydrocarbon Reservoirs
- CO_2 EOR Record (NMT)
- Gas & Condensate Compatibility (TTU)

Coal Reservoirs
- CBM Potential & CO_2 Capacity (INEL)

Saline Aquifer Reservoirs
- CO_2 Movement & Immobilization (UT)

Transportation
- Corrosion & Materials Selection (IFE / Reinertsen)
- CO_2 Impurities (Battelle)

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Integrity

Natural & Engineered Analogs
- CO_2 Reservoirs (ARI)
- Leaky Systems (Utah State)
- Natural Gas Storage Experience (GTI)

Reservoir & CapRock Competence
- CO_2 / Rock Changes at Reservoir P&T (GFZ-Potsdam)
- Reactive Transport Modeling (LLNL)

Well Materials
- Cement / Steel Corrosion / Erosion (SINTEF)

Monitoring

Geophysical
- Seismic Resolution & Modeling (TNO)
- Seismic Resolution & Costs (LBNL)
- Novel Non-Seismic (LBNL)

Geochemical
- Noble Gas Tracers & Costs (LLNL)

Satellite & Aerial
- InSAR Resolution (Stanford)
- Hyperspectral Geobotanical (LLNL)

Near Surface, Surface & Atmosphere
- State-of-the-Art & Strategies (Caltech)
- Eddy Covariance (Penn State)

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Progress in other program areas

- **Policy and Incentives** - conducted review of current policy matters and identified opportunities and barriers for technology development and application
- **Technology Advisory Board** – provided an unbiased review of project technology and progress
- **Communications** – communications strategy and engagement of NGO's from an early stage.
  - Website, Video & Brochure available
  - Peer review of results
  - Two volume book available Q4.

Conclusions

- Industry & governments have come together on an international scale, to provide strong leadership on technology development
- A portfolio of technologies with broad application have been developed and represent state-of-the-art
- Technology R&D is producing step reductions in cost
- CO_2 sequestration must be proactively managed to reduce risks and ensure broad acceptance
- Communication and publication of results is in hand.
- Visit www.co2captureproject.org - for more information
- Planning in hand to build on this success with CCP2

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End of Presentation

Questions ?